



# EFFECTS OF DROUGHT ON COMMUNITY DYNAMICS OF VERNAL WETLANDS ON CAPE COD

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## QUESTIONS:

- How sensitive are vernal wetland plant communities to natural variations in water table depth?
- Are potential changes in community structure related directly to biophysical processes (e.g., SOM accumulation, pH) of vernal wetlands?
- What are the implications for management?

E2



Effects of Drought on Plant Community Distribution -E2

E8

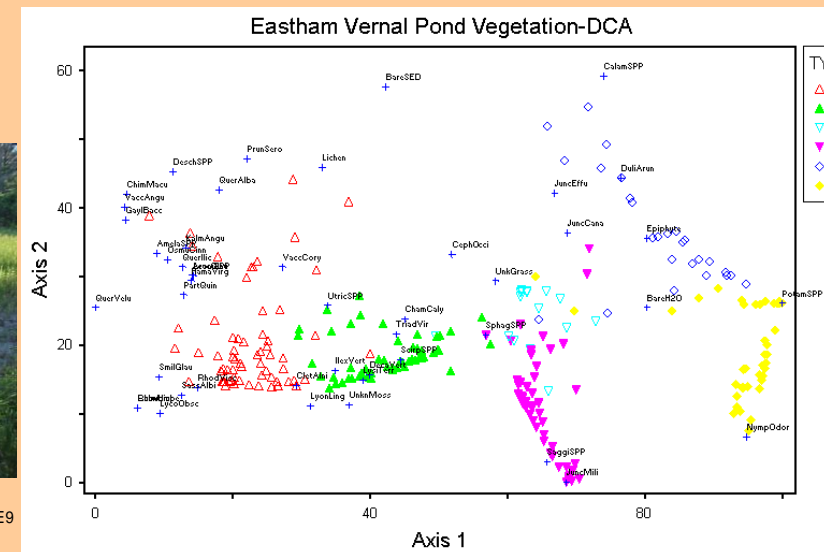


Effects of Drought on Plant Community Distribution -E8

E9



Effects of Drought on Plant Community Distribution -E9



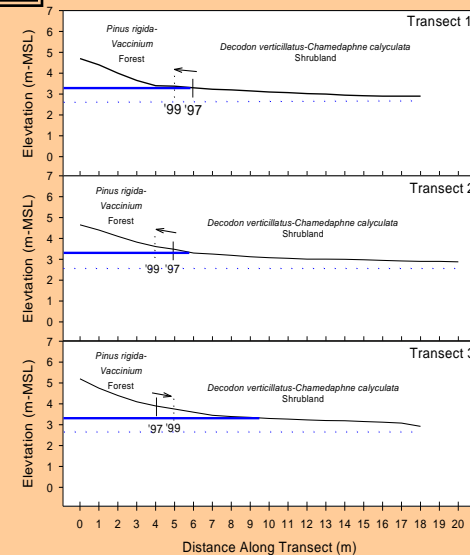
DECORANA of 257 1 x 1-m plots and 47 species for all sites combined (1997 only - 1999 similar). The numbers in the legend correspond with the six plant communities depicted below.

## DISCUSSION/CONCLUSIONS:

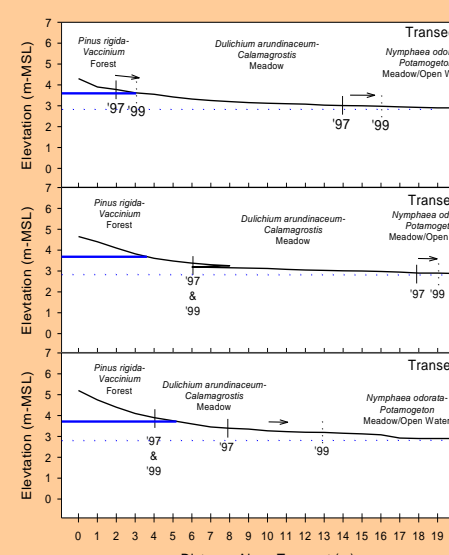
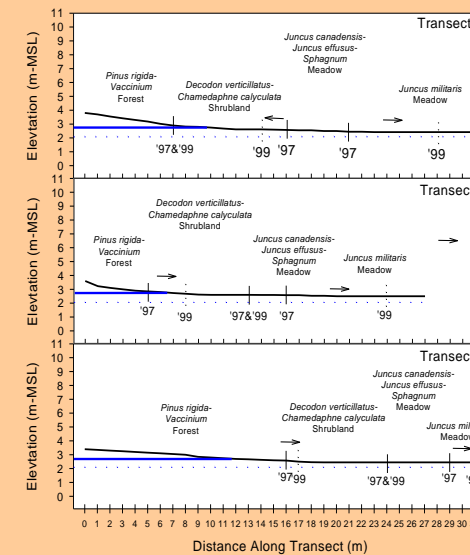
- The degree to which plant communities tended to move downslope during a single year of drought was very surprising and suggested many of the dominant species are quite sensitive to water stress over short time scales.
- The great variation in composition and physiognomy between these three wetlands (all in close proximity to each other) suggests that more detailed and extensive research is required to adequately characterize vernal wetlands on Cape Cod.
- Predictably, the depth to the water table appears to be the most important environmental variable controlling community composition. The depth to water table mediates apparently intense competition such that relatively small depressions can tip the balance toward upslope species.

## APPROACH:

- Three vernal wetlands (E2, E8, E9) were selected to represent the range of elevation, spatial extent, and location on the groundwater lens of vernal wetlands at Cape Cod National Seashore (CCNS). Data were collected from these sites in 1997 (WET) and 1999 (DRY).
- In each wetland, three belt transects (random bearings) were arranged along elevation gradients from the rim to the bottom of the bowl. Species abundance by cover class was measured by point intercept in 1-m increments along each transect.
- Pore water characteristics (water potential, water content, chemistry) and soil characteristics (SOM, bulk density, nutrients, pH) were quantified at five stations along each transect. Detailed evaluations of the biogeochemical responses are being analyzed in a complementary study.



Slope profiles illustrating community dynamics along elevation gradients during wet and dry years

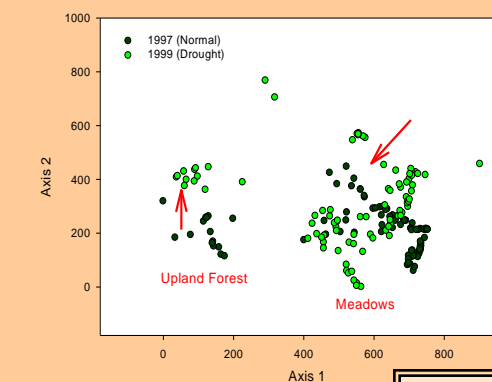
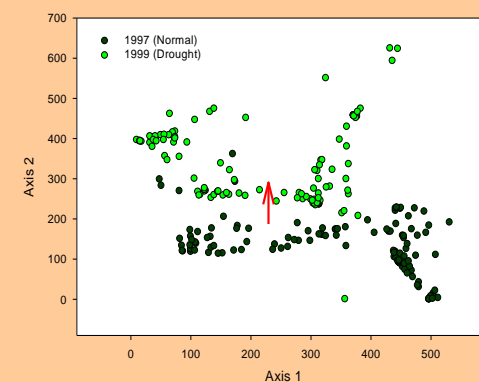
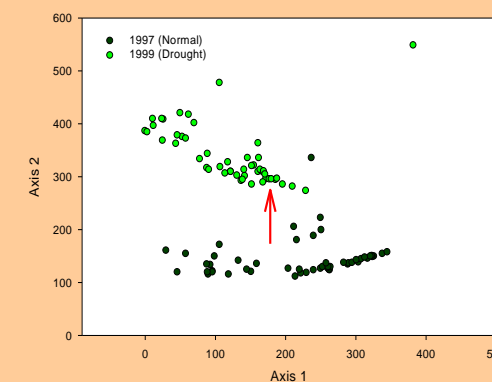


Water Table in July 1997 (WET) Water Table in July 1999 (DRY)

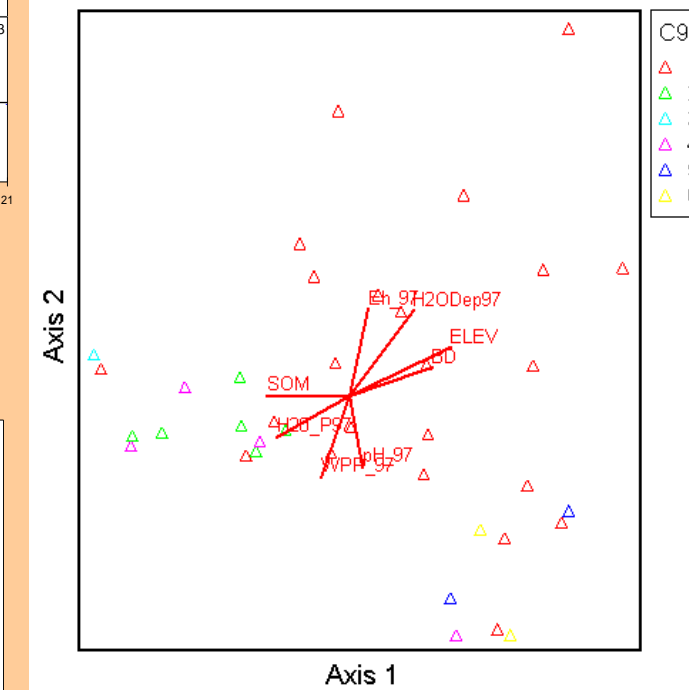
DCA Wet vs. Dry - Vernal Pond Vegetation - E2

DCA Wet vs. Dry - Vernal Pond Vegetation - E8

DCA Wet vs. Dry - Vernal Pond Vegetation - E9



## Eastham Vernal Pond Vegetation - CCA - Stations



Canonical Correspondence Analysis (CCA) of 38 1 x 1-m station plots (1997 only - 1999 similar). The numbers in the legend correspond with the six plant communities depicted below. The joint plot indicates the direction and strength of relationship between depth to water table (H2Odep), soil organic matter (SOM), elevation (ELEV), bulk density (BD), soil water potential (WPP), pH, and soil moisture (H2O\_P). NH<sub>4</sub>N and total P had  $r^2 < 0.2$  and were discounted.

## MANAGEMENT IMPLICATIONS:

- These data provide us with clear, quantitative evidence of the sensitivity of vernal wetlands to water table depression. This enables informed management decisions by Cape Cod National Seashore in the face of local pressure to develop municipal water wells adjacent to Park boundaries in this area.
- Along with past and ongoing studies of park biota and biophysical processes, this study emphasizes the importance of vernal wetlands within the larger landscape context, greatly disproportionate to their land area..

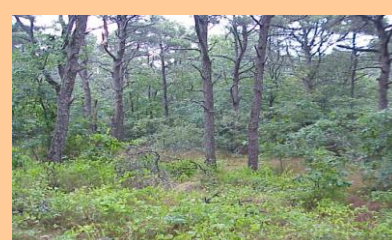
## PROPOSED FUTURE RESEARCH:

- Testing the results of this study through field and laboratory manipulative experiments (e.g., microcosm watering trials, reciprocal transplanting in the field to ascertain competition).
- Repeated sampling of vegetation and abiotic parameters over longer timescales as part of the Cape Cod Inventory & Monitoring Program.

## DESCRIPTION AND ANALYSIS OF PLANT ASSOCIATIONS:

TWINSPAN (Gauch 1982) was used to classify species and plots into plant associations. Detrended correspondence analysis (DCA; Hill and Gauch 1980) and canonical correspondence analysis (CCA; ter Braak 1986) were used to examine patterns of similarity/dissimilarity by association type. Indicator species analysis (Dufrene and Legendre 1997) was utilized to describe each group. All procedures were computed using PC-ORD, Version 4 (McCune 1999). Six plant communities were identified:

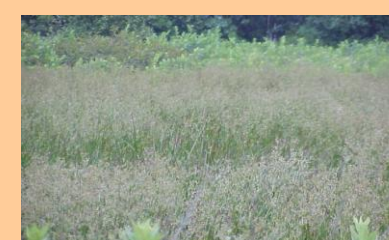
DECORANA's by site and year (WET vs. DRY) depict community shifts in ordination space. Red arrows indicate the general direction of movement of particular plots. For E9, there were two general trends depending on the community type.



*Pinus rigida* - *Vaccinium* spp. - *Deschampsia flexuosa* UPLAND FOREST (#1)



*Decodon verticillatus* - *Chamaedaphne calyculata* THICKET (#2)



*Juncus canadensis* - *Juncus effusus* - *Sphagnum* SEDGE MEADOW (#3)



*Juncus militaris* SEDGE MEADOW (#4)



*Dulichium arundinaceum* - *Calamagrostis* spp. MESIC MEADOW (#5)



*Nymphaea odorata* - *Potamogeton* spp. OPEN WATER/ MEADOW (#6)

## LITERATURE CITED:

- Dufrene, M., and P. Legendre. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* 67:345-366.
- Gauch, H.G., Jr. 1982. *Multivariate Analysis in Community Ecology*. Cambridge University Press, New York, NY, USA.
- Hill, M.O., and H.G. Gauch. 1980. Detrended correspondence analysis: an improved ordination technique. *Vegetatio* 42:47-58.
- McCune, B., and M.J. Medford. 1999. *PC-ORD: Multivariate Analysis of Ecological Data, Version 4*. MjM Software Design, Gleneden Beach, OR, USA.
- Ter Braak, C.J.F. 1986. Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology* 67:1167-1179.